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ABSTRACT

Using similar research in Britain as a basis, a study in New Zealand explored schema learning in young children. The primary purpose of the study was to determine the effects of a curriculum intervention designed to increase the richness and amount of stimulation teachers and parents give 4-year-olds in response to observations of children's fascination with particular schemas. One of the key findings of the British study was that there are patterns of repeated actions in the play of children this age as they explore a particular notion, such as parallel lines. In both the British and New Zealand research, children whose teachers and parents reinforced their schema-related activities scored higher than their peers in various areas of competency. Implications for early childhood practitioners and neuroscientists include the following: (1) patterns in children's actions and behavior may indicate there is programmed development of neural pathways during certain periods in young children's growth; (2) when relevant enriching experiences are available, they facilitate increased repetition of behavior that seems to be associated with the strengthening of synapses for spatial-visual and other aspects of development; (3) representation of "thoughts of forms," such as grids, is a schema-related activity involving several senses, and therefore different parts of the brain; and (4) the strengthening of neural pathways is afforded by eclectic, playful experiences that have a focus to them, a self-organized focus on the schemas, although adults may not see such play as purposeful. (Contains 20 references.) (EV)

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Schema learning, and its possible links to brain development

by

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New Zealand Fulbright Senior Scholar, 1999

A seminar to post-graduate neurology students at the invitation of Professor Harry Chugani

Children's Hospital of Michigan
Wayne State University
Detroit, Michigan

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Seminar

Children's Hospital of Michigan
Wayne State University, Detroit
Presented to
Professor Harry Chugani's
Postgraduate team

18 November 1999

1. Introduction

A brief personal biography will help to explain my growing interest in recent neuroscience findings in my role as a leader in early childhood education in my home country, New Zealand. I am a mother and grandmother, watching family members grow and develop; my mother suffered with a neurological disease - Alzheimer's disease; and my career in early childhood education has involved special education and visits to conductive education settings.

Today, I will describe a research project on 10 young children's actions in relation to so-called schema learning and subsequent revisions in my own thinking about schemas, as I learn more about. In the second part of my seminar, I want to explore with you my ideas about young children's brain development and the functions of play and early education experiences from my recent reading.

2. *Thinking children*: learning about schema

The New Zealand schema learning project (Meade, with Cubey, 1995), built on UK research on a similar topic (Athey, 1990). The primary purpose of our study was to see the effects of a curriculum intervention designed to increase the richness and amount of stimulation teachers and parents give 4 year olds when they observe children who are fascinated by schemas. Schemas have been defined as forms of thought by Chris Athey, the principal researcher of prior research on schemas in early education settings in the UK.

The UK researchers carried out intensive daily observations of the same 20 children aged 3 and 4 years in a nursery school for two years. One of their key findings was there are patterns of repeated actions in children in this age group *at play* as they explored a

particular notion, which appeared to be an implicit idea. Athey called these patterns schemas. Another researcher has used an alternative term, "threads of thought" (Nutbrown, 1994). The schemas that Athey, and Nutbrown identified in young children's play are to do with lines, curves and space order. Those project teams shared these insights with the parents at regular intervals during the research.

The IQ of the children who were studied in the UK increased and was significantly higher than their peers from comparable below-average income families. Moreover, their younger (but not older) siblings also scored higher than the expected IQ scores, presumably because the parents had learned how to enrich their children's experiences.

In the New Zealand research, we shared the UK findings with our 10 subjects' teachers and parents, and worked to motivate these adults to enrich the children's experiences and thinking about these schemas. They did to a greater or lesser extent, depending on the early childhood service's circumstances.

What did the New Zealand early childhood teachers do? What curriculum adaptation was made? Generally, the teachers worked on affording the children more relevant experiences once they spotted a surge of interest in a schema by a child. Thus, if a child was fascinated by horizontal lines that connect A and B, then the teachers provided more materials for children to connect; e.g., string, ribbon, Mecano, train sets, and the like. They did *not* give "lessons" for children to simply listen and/or observe on connection, levers and such like. New Zealand teachers would regard such lessons as inappropriate for 4 year olds. We are less clear about what the parents did. They told us they found it fascinating that children learn through repetition in play in this way. We assume, therefore, that their attitudes to repetitious behavior – and to play more generally - became more positive.

The effect of the *provision of more diverse experiences* by the New Zealand adults, after a few months' of interventions, was that these children did better than a matched sample on a range of measures of competencies in the language, motor and social domains. Their scores related to learning dispositions - such as perseverance - were also better. We did not measure IQ.

For early childhood practitioners, the point (and effect of the reports) of the research in New Zealand and the UK has been to increase their thinking and actions in relation to children's thinking:

- Their observations of children have increased to find out more about children's thinking (generally early educators have been better at observing children's socio-emotional development); and
- Adults' beliefs about the nurture-nature debate, and *their* associated practice have changed; i.e., the findings changed teachers' belief in the innateness of many of these competencies. They came to believe more strongly in the effects of experience, and they took more responsibility for strengthening learning in children.

For this audience of neuroscientists today, relating these findings to brain development knowledge, I think some of the key discussion points might be:

a. That the patterns in children's actions and behavior may indicate there is programmed development of these sorts of neural pathways during certain periods in young children's growth.
b. That when relevant (additional) enriching experiences are available they facilitate increase repetition of behavior that seems to be associated with the strengthening of synapses/pathways for spatial-visual and other aspects of development.
c. That representation of thoughts of forms – such as grids - is a schema-related activity involving several senses, and therefore pathways between different parts of the brain.
d. That the strengthening of neural pathways is afforded by eclectic, playful experiences that have a focus to them, a self-organized focus on the schemas, although adults may not see such play as purposeful.

What have I learned about schemas since the time of that study?

A. My use of the term "schema", or rather the phrase "learning about schemas", may be rather imprecise and confusing. The term schemas or schemes for many scholars connotes with a structure in the brain that is innate and cannot be changed by experience. I am not sure whether the issue for them is that the term schemas should only refer to patterns in the brain not patterns of actions, or that schemas are brain hardware and any brain hardware is set in concrete.

Let me deal with these one at a time. First, in relation to schemas as patterns in the brain or patterns of actions, I propose to separate them from hereon. I will use the term "schemas" to refer to patterns in the brain, the threads of thinking. I suggest they are part of memory. The associated patterns of repeated actions will be referred to as "schema-related activities".

Second, the network of schema researchers that I link with has observed progressions in schema-related activities in young children. The sequence is from motor action, to representation, to abstract thought. From my reading of the brain research written for lay people like myself, the repetition and progression in schema-related activities will be linked with the "brain hardware … updating itself to meet the sensory, motor, emotional, and intellectual demands on hand," (Eliot, 1999, p.4). Thus, I am suggesting that changes in memories of schema occur, as well as changes in schema-related activities. It is likely that more complex understandings emerge as the abilities necessary to represent and think in the abstract, mature. After that higher level of organization occurs, there may be renewed interest in one or more schemas. A dynamic process reactivates. Then, "through repeated practice, the system self-assembles into the new form" (Thelen & Ulrich, 1991, p.91). Mostly, it is the child who is the active agent in learning by

creating or seeking repetitions, if the environment allows. Steven Rose (1997) calls this self construction. Writers (such as the Rutters, 1993) agree that this is the one element of Piaget's theory of cognitive development that has stood the test of time.

B. Maybe what we've focused on could more accurately be described as *thoughts of form*, than forms of thought. Remember, that the schemas that were identified fell into three categories: lines, curves and spatial order.

On my way to the Mid-West from my Pacific homeland, I stopped in California for three days and, amongst other things, visited the new Paul Getty Center and took the architectural tour. Our guide explained that the basis of that wonderful center is squares (3x3) and curves, and three building materials, and of course spatial relationships. The point to my anecdote is that the schemas to do with *form* that seem to fascinate young children are very significant in what has been called our "carpentered" environment. (Eliot, 1999, p.209) At least one other researcher - I have forgotten where I read this - has found that children raised in different sorts of habitats don't use lines and angles like our children do in their representations.

Our New Zealand research showed that surges of fascination with particular schemas were associated with children representing 'their' schema in many and various ways. A child interested in parallel lines might line up all the shoes she could find in parallel lines, so too the cutlery, and pencils. She would be interested in parallel wheel tracks, and make some for herself, given the means. You would see parallel marks more often in her art. And her constructions may feature parallels in their layout. Thus, it would appear to observant adults that she is seeing parallels in many places in her environment, and she is making things parallel so that she can touch and think about parallel objects. Sometimes her representations would be static, and later they would be dynamic as well.

3. Some things to ponder about schemas

My reading in brain development emphasizes that "everything a child sees, touches, hears, feels, tastes, thinks and so on translates into electrical activity in just a subset of his or her synapses, tipping the balance for long-term survival in their favor," (Eliot, 1999, p.32; also, Shore, 1997, p.2). So which subsets of synapses are these surges of schema-related activities favoring? Are they to do with visual brain development? For example, are they to do with the "what" pathway of the visual development (related to shape and details of visual targets)? These are generally static. Or are they to do with the "where" pathway of visual development (related to location in space). These would more likely be dynamic representations. Or do schema-related activities provide practice in analyzing several visual features simultaneously? Whichever, from reading the literature on brain development, I deduce that these periods of fascination with particular schemas probably coincide with an important phase in brain development. Do neuroscientists know which associated biological processes are involved - synaptic growth, synaptic pruning and/or myelination? I've not yet found a definite answer in the literature.

Are schema-related activities indications of processes that don't register in conscious memories but nevertheless allow memories of form to take hold by repetitious, albeit often fleeting experiences? In the sequence of schema-related activities, children too young to have a "real" memory were initiating repeated action and representational experiences in their play related to their threads of thinking. Were we observing children storing implicit memories? They were gaining skills and knowledge through experience, but were seldom aware of them. (Nor, for that matter, were the adults around them until the researchers drew attention to them.). Later in the sequence of schema-related activities some children did experiment with transformations of a particular form, or discussed some properties of objects exhibiting that form, thus demonstrating consciousness of it.

Are these explorations additionally a means for children to learn about the properties of objects in their world, or starting to develop working theories of those properties?

4. Does working on schema-related activities (and schemas) matter?

There are at least two questions here: (a) does it matter whether or not *children* work on schema-related activities? (b) does it matter whether or not *adults* facilitate children's work on schema-related activities? My answers are mostly speculative.

First, let me make some suggestions about children's schema-related activity. The patterns in young children's schema-related activities in their play have been observed now by many researchers and by even more educators – parents and teachers. However, until the research findings came out, adults have not been conscious of them. Thus, they seemed to be programmed actions. Why? If this activity is related to visual development and implicit visual memories - and I suggest at minimum it is – then these perceptual play activities assist with forming implicit memories related to our physical environment - in our case, it is a "carpentered" environment". I would argue that these schemas also lay the groundwork for reading and writing. Discriminating and integrating static lines, curves and two-dimensional space order are at the core of working with the written symbols we use for words.

Is this activity is also related to learning and the development of thinking? I suggest it is – these sorts of play activities involve cognitive processes of attention, recognition, categorization, recall, and holding onto ideas and manipulating them. The girl with a parallel lines schema instructs us on this point.

Second, let me talk about the adult role. Does it matter whether adults facilitate and enrich children's schema related activities? Our New Zealand data indicated that adult enrichment of the play environment for a group of 4 year olds in two early childhood settings (and possibly at home as well) for a semester resulted in better scores than those of a comparison group in comparable settings. Moreover, these scores were not only for early mathematics and literacy, which is what was predicted, but also for talking and listening communication, for social skills, and for a learning dispositions – perseverance

Remember that the teachers' intervention was an enrichment-of-resources program. There was fairly minimal language input or prompts to engage in joint attention processes. A New Zealand academic is currently working on action research to get staff to progress beyond identification of schemas and enrichment of the environment - quite common practice since our research - to joint engagement with individual children's interest (Jordan, 1999). Her study is focused on changing teacher practice, and won't measure child outcomes, unfortunately. However, there is an underlying assumption in her action research that joint adult-child engagement makes more of a difference for children's learning than play without adult engagement. Recent research in the area of developmental psychology would support this assumption (e.g., Rogoff, 1990; Bertram, (1995); Smith, 1998).

What is likely to happen where there is engagement? Colwyn Trevarthen (1990), and Daniel Siegel (1999), says that children's brains "are specially coupled, by emotional communication, to the regulators of adult brains of people who know more." (Trevarthen, 1990, p.357) Trevarthen is referring in particular to cultural learning that takes place "not in single brains, but in communities of them." (Ibid.). Siegel refers mainly to parents and children. Do these states apply to other learning and development areas as well? Developmental psychology research suggests it does. How? Siegel (1999) states that

> "[O]ne mind can directly influence the activity – and the development – of another through the transfer of energy and information. This joining process occurs via both verbal and nonverbal behavioral responses, which function as signals sent from one mind to another." (p.277)

Thus, teachers and/or parents, by warmly engaging with children and signaling that information about a topic is of considerable interest, can enhance children's attention to and pass that information.

5. What about the role of play in brain/mind development?

Throughout this presentation, I have been describing schema-related activity by children when playing. Why is play activity important for children's development? Play affords children the opportunity to use their senses in combination to experience the world – they *see*, *feel* and possibly *smell* the objects they are playing with. They will probably also *hear* language associated with their activity – from adults, from peers, or from their own mind. Lilian Katz (1997, p.3) says that play behaviors are dynamic "in that they cause reactions within the organism and between it and its environment that create changes in behavior that, in turn, cause reactions." This description reflects the views of Steven Rose about biological development – he talks about the "interpenetration" of organisms and the environment. Does the brain as well as behavior change in these iterative processes?

Play is also usually carried out when children feel positive about their experiences. Thus, their emotional state is likely to be conducive to memory formation.

Research on the effects of different early childhood curriculum approaches have shown that too much teacher-directed instruction has neutral or negative impacts on young children's development, whereas approaches that allow for considerable opportunities for children to play enhance children's development and their disposition to learn.

Since the so-called age of childhood (Jenks, 1996), most young children have spent the majority of their days in free-flow play. Do they need this sort of play - - what Tina Bruce (1991) calls free-flow play (free form) or does play that has explicit constraints by adults work just as well? It is during free-flow play that children exhibit schema-related activity. Does it matter if they get less free-flow play?

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